

**EFFECT OF DIFFERENT
WIND FORCINGS ON A
BAROTROPIC
OCEAN MODEL'S
ABILITY TO FIT TOPEX &
BOTTOM PRESSURE DATA.**

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OVERVIEW

- ▶ Fukumori et al (1997), Stammer et al (2000) and Tierney et al (2000) showed that the ocean's short-period response to wind, and departures from IB, alias altimetry significantly, a 'correction' not currently available. Gravity missions especially need such dealiasing.
- ▶ In previous work (Hirose et al., 2000) we optimized the configuration of a barotropic ocean model to dealias altimetry from the effect of the ocean response to wind and pressure at periods shorter than 20 days. In that work, the effects of friction, bottom topography and no-slip conditions were optimized to match data.
- ▶ Here we first focus on the effect of various wind products, the key forcing function.
- ▶ We also show that an operational, 8+ year run exists, with reasonable results.

WIND PRODUCTS COMPARED

- ▶ NCEP near-real time is freely available; ECMWF in near-real time is difficult to obtain outside of Europe.
- ▶ Possible problems in the conversion of wind to surface stress, due to PBL model weaknesses
 - ▶ NCEP REANALYSIS, surface stress.
 - ▶ NCEP REANALYSIS, 10 m above the surface, Kondo*.
 - ▶ NCEP REANALYSIS, 1000 mbar, Kondo*.
 - ▶ NCEP REANALYSIS, 1000 mbar, Kondo*, 24 hr 2-pass ave.
 - ▶ NCEP OPERATIONAL, 1000 mbar, Kondo*.
 - ▶ ECMWF OPERATIONAL, 1000 mbar, Kondo*.

All products on a 2.5° grid.

Kondo* = conversion of 10 m wind vector to stress according to
Kondo, J., 1975, Air-Sea Bulk Transfer Coefficients in diabatic conditions
Boundary Layer Meteor., 9, p91-112

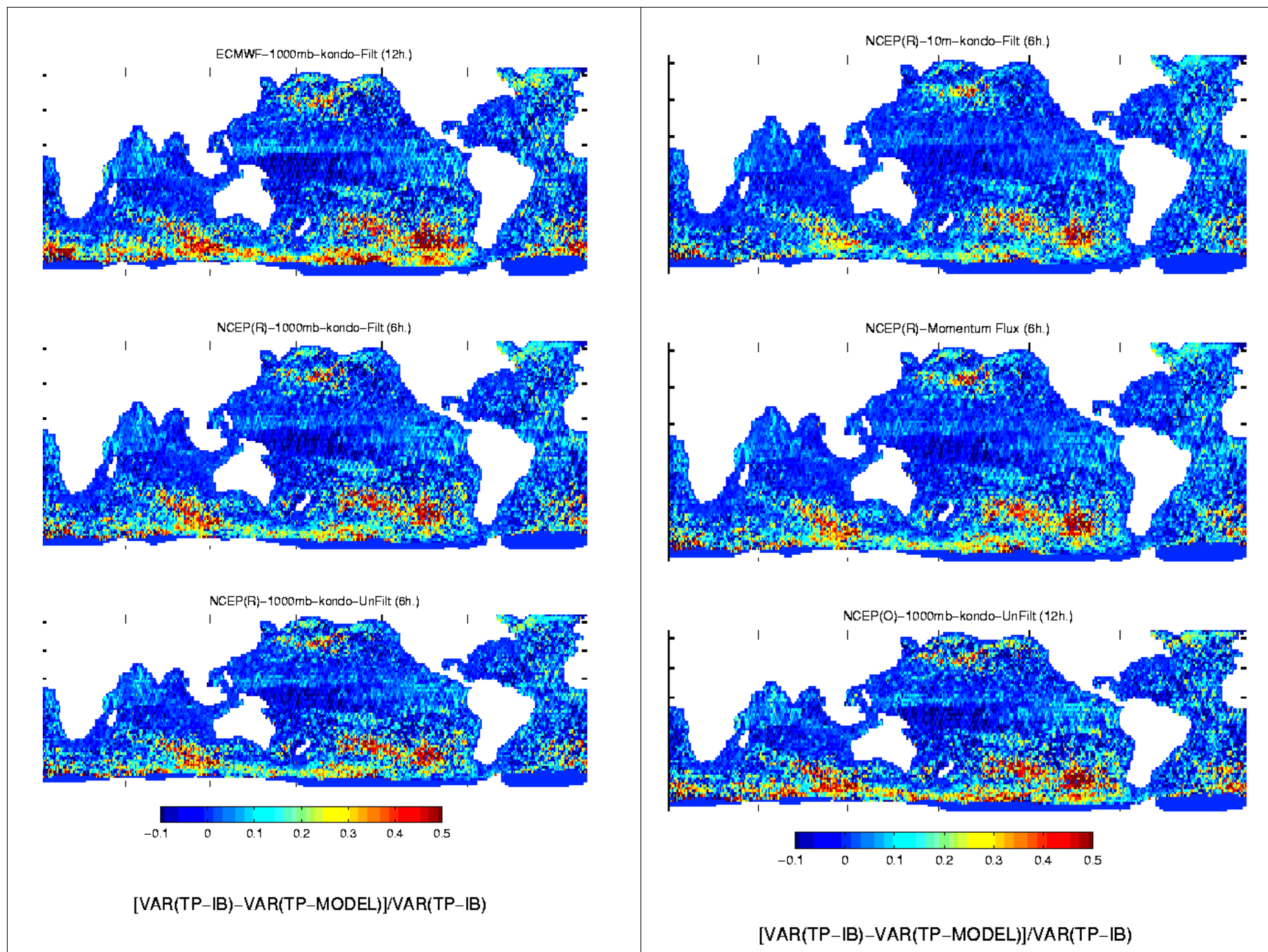
MODEL DESCRIPTION

- ▶ Barotropic model of Ponte (1993, 1997), with following modifications (Hirose et al, 2000):
 - ▶ subsurface no-slip condition
 - ▶ fine topography
 - ▶ optimized friction parameter: $-bu/H$, $b=2$ cm/s
- ▶ Resolution: $1.125^\circ \times 1.125^\circ$
- ▶ Coverage: global, 75°S to 65°N .
Not included: Mediterranean, smaller enclosed seas and bays.
- ▶ Winds and pressure: 6 hourly, from NCEP or ECMWF, operational or reanalysis.

VARIANCE REDUCTION

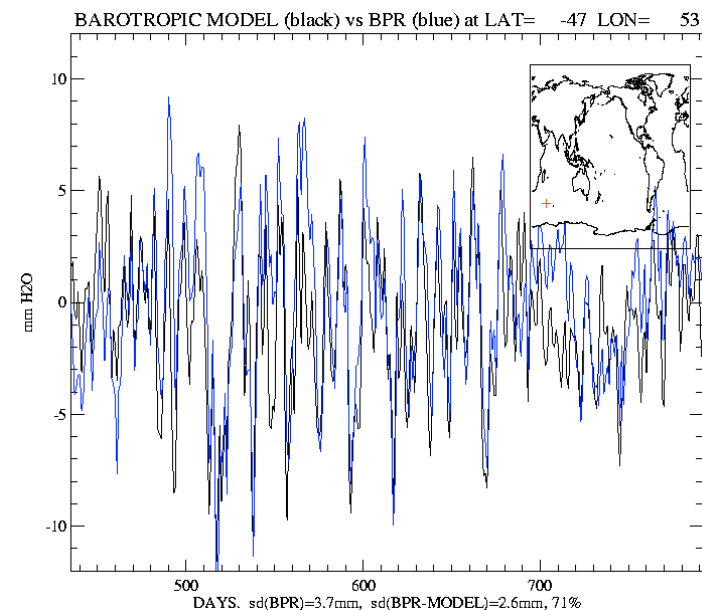
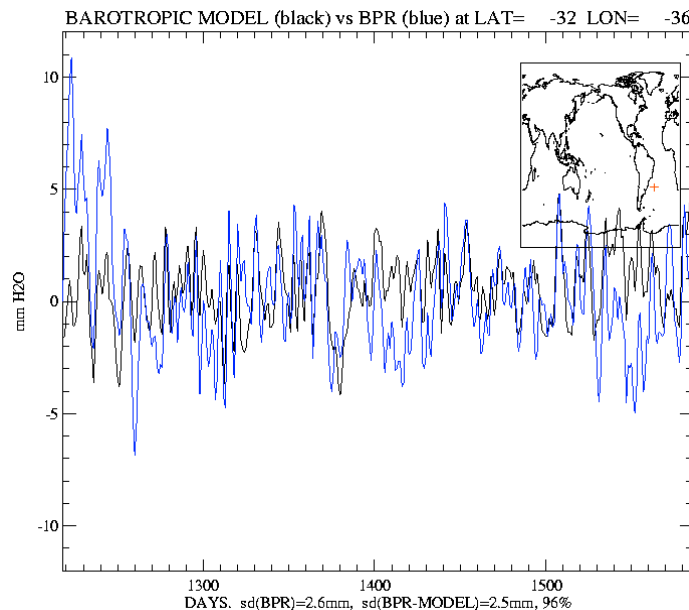
from TP DATA due to MODEL

- ▶ The six figures below show the relative reduction in variance $(\text{var}(\text{TP-IB}) - \text{var}(\text{TP-model})) / \text{var}(\text{TP-IB})$ for each of the six wind/pressure forcings used.
- ▶ We remove IB from the comparisons to highlight the improvement due to the wind forcing.
- ▶ In certain southern regions, 40% or more of the TP variance is explained by the model, most of it a high frequency response.
- ▶ In the Warm Pool region, the model actually increases data variance. The response is not barotropic at all.
- ▶ Both the operational ECMWF and NCEP forcings for 1999 remove more variance than NCEP reanalysis (discussed below)



VARIANCE REDUCTION in BPR DATA due to MODEL

- The two figures below illustrate the match between the model output and selected Bottom Pressure Recorders (from <http://www.pol.ac.uk/psmslh/gloup/gloup.html>). The spatial coverage of BPRs is limited, so we show two representative samples.
- The numbers beneath the figures show that variance of the corrected BPR is 96% (worst) or 71% (best) of BPR variance.

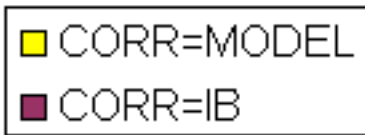


VARIANCE REDUCTION

from TP DATA due to MODEL

- ▶ The figure below shows the globally-averaged relative reduction in variance
$$(\text{var}(\text{TP}) - \text{var}(\text{TP-corr})) / \text{var}(\text{TP})$$

where CORR(ection) is one of the full model output, or the IB response to pressure only.
- ▶ As before, ECMWF and NCEP operational do a better job than NCEP reanalysis. This is not surprising, as the models have evolved.
- ▶ In an earlier version of this calculation (10/2000) we stated that NCEP operational performed very poorly. This was our mistake, introduced when trying to make up for missing files in the NCEP operational stream. It is still true that NCEP operational requires special handling, due to missing data, but it performs even better than ECMWF operational for these purposes.



$$[\text{VAR}(\text{TP}) - \text{VAR}(\text{TP} - \text{CORR})] / \text{VAR}(\text{TP})$$

WIND SOURCE ▼

KND(ECMWF,1000mb)

KND(NCEP-O,1000mb)

FLX(NCEP-R)

KND(F(NCEP-R,1000mb))

KND(NCEP-R,1000mb)

KND(NCEP-R,10m)

ALL FOR JUL-DEC, 1999

NCEP-O: operational, 2.5

NCEP-R: reanalysis, 2.5

ECMWF: operational, 2.5

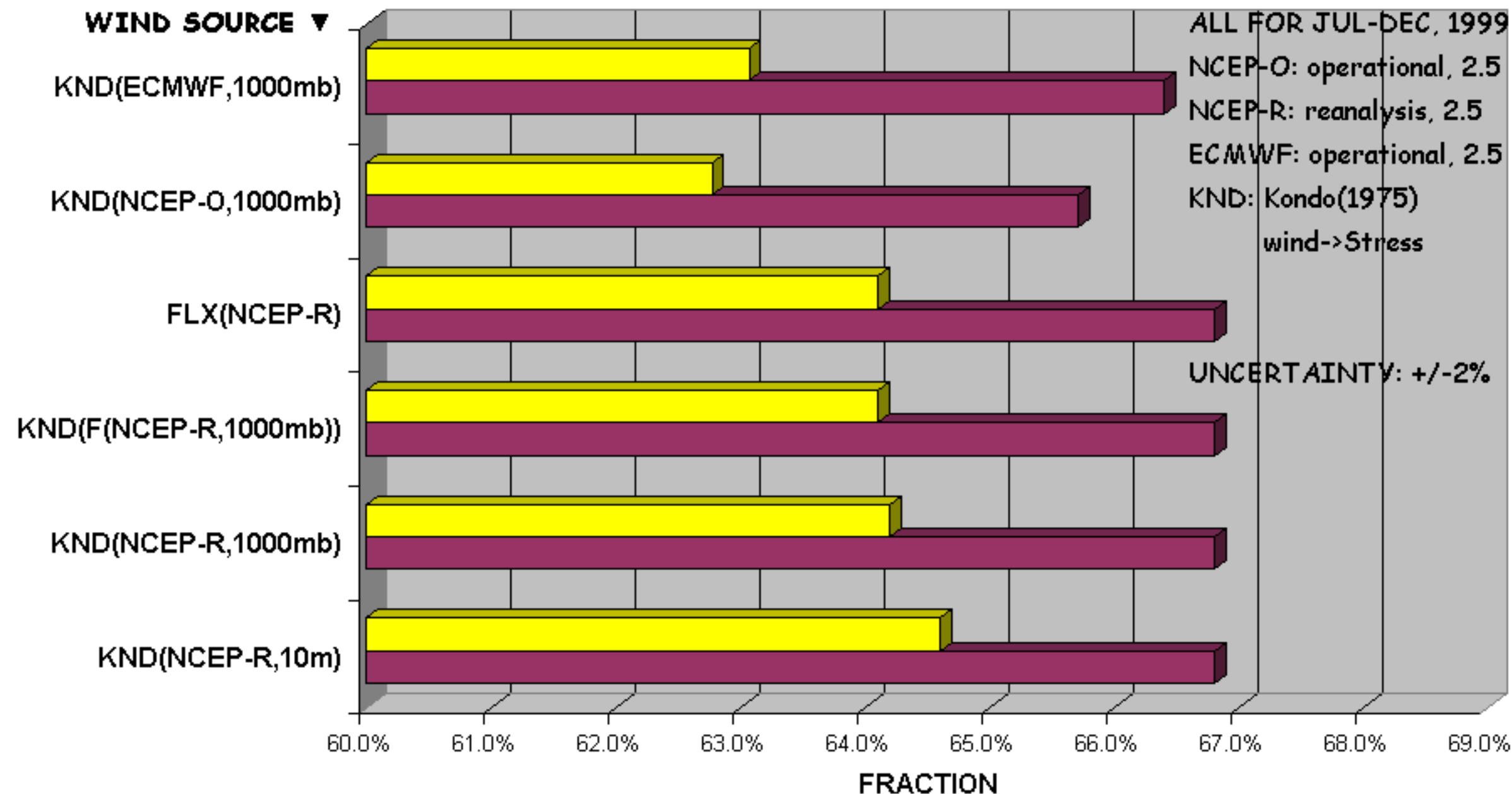
KND: Kondo(1975)

wind → Stress

UNCERTAINTY: +/-2%

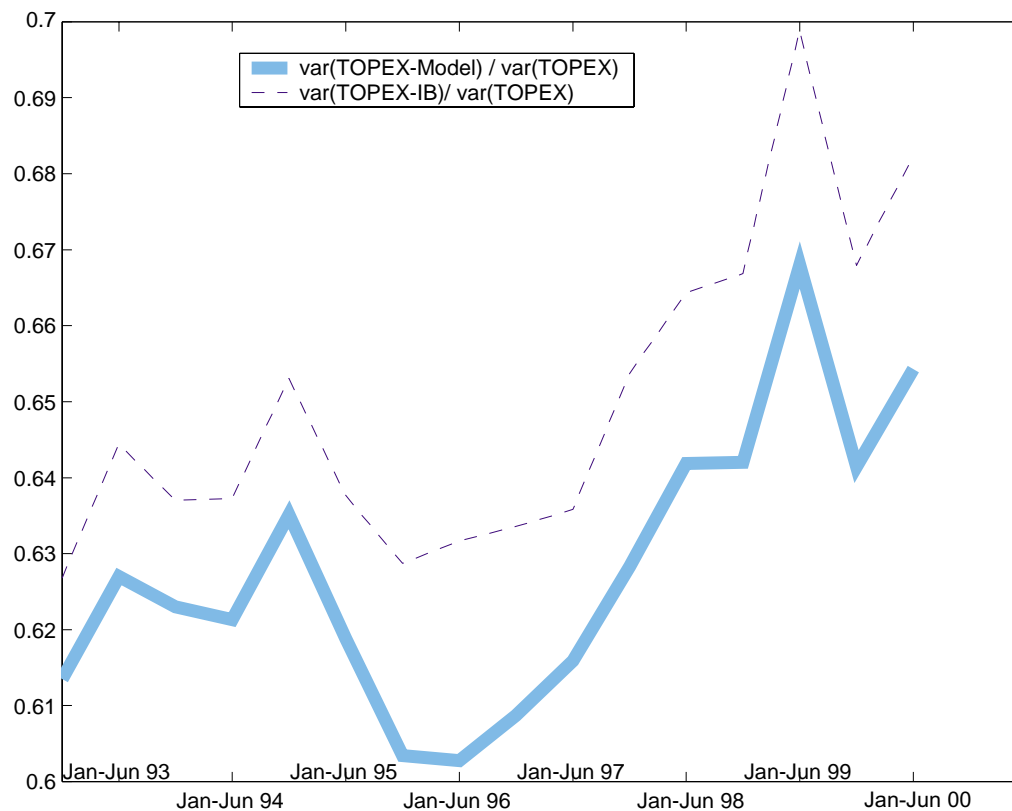
60.0% 61.0% 62.0% 63.0% 64.0% 65.0% 66.0% 67.0% 68.0% 69.0%

FRACTION



AN OPERATIONAL MODEL

- ▶ While this presentation focusses on the effect of different wind products, we do have a reasonably good operational correction for 1992-2000 based on NCEP reanalysis (figure below).
- ▶ Clearly the model removes more variance than just IB at all times.



CONCLUSIONS

- ▶ In the Southern Ocean, this barotropic model explains up to 40% of the TP data variance, most of it a high-frequency signal. This is in agreement with previous work.
- ▶ An 8+ year model run to dealias TP and ERS altimetry was completed using NCEP reanalysis press. & 1000 mbar winds.
- ▶ Experiments with different atmospheric forcings showed that both current (1999) NCEP and ECMWF operational press. and 1000 mbar winds outperform the NCEP reanalysis.
- ▶ The NCEP operational product actually reduced more variance than the ECMWF product for 1999. The NCEP product is freely available, but occasional missing files require special handling.
- ▶ Our intention is to use the NCEP reanalysis until 1999 (for T/P, ERS altimetry), and NCEP operational thereafter.
- ▶ The most urgent improvement is adding Mediterranean Sea.